



Garden Cress Seeds a Promising Alternative for the Development of Nutrient Dense Muffins

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Authors' contributions

This work was carried out in collaboration among all authors. Authors JJ and VR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JJ, Sonia, Reena and VS managed the analyses of the study and interpretation of results. Authors Sonia and Reena managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/EJNFS/2020/v12i930295

Editor(s):

(1) Dr. Adetunji Charles Oluwaseun, Edo University, Nigeria.

Reviewers:

(1) R. S. Bello, Federal College of Agriculture, Nigeria.

(2) Rekha Rani, Sam Higginbottom University of Agriculture, Technology and Sciences, India.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/61107>

Original Research Article

Received 08 July 2020
Accepted 13 September 2020
Published 24 September 2020

ABSTRACT

Aims: Garden cress seeds are highly nutritious super grain, that possess galactagogue, antioxidants, anti-inflammatory, antidiabetic, hypocholesterolemic, hepatoprotective activities and also suitable for celiac patients as they do not contain gluten. This study was conducted to develop and evaluate nutrient rich muffins supplemented with GCS, so as to utilize their full potential.

Study Design: Control muffins were developed using refined flour as a basic ingredients which was replaced with 10, 20 and 30% of GCS in experimental muffins.

Methodology: GCS were roasted at 150°C for five minutes to remove the peppery after taste. Roasted GCS were used to develop muffins. Control and experimental muffins were evaluated for sensory characteristics and nutritional parameters (proximate composition, dietary fiber, total and *in vitro* bio-accessible minerals, phytic acid and antioxidants).

Results: Muffins supplemented with 10 and 20% of GCS scored higher than the control muffins for sensory parameters i.e. colour, texture, aroma, taste and overall acceptability however muffins supplemented with 30 GCS scored slightly lower than the control muffins. Both the experimental and control muffins adjudged between 'liked moderately' to 'liked very much' by the judges. The

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contents of protein (13.23-15.59%), fat (20.57-20.99), ash (1.77-2.64%), total dietary fiber (7.98-12.37%), total calcium (91.32-155.99 mg/100 g) and iron (4.83-8.06 mg/100 g) and antioxidants were increased significantly in all the three levels (type-I, type-II and type-III) of GCS supplemented muffins.

Conclusion: Nutrient dense muffins with superior nutritional quality can be developed using GCS up to 20 % without compromising sensory acceptability. Consumption of nutrient dense muffins may be beneficial in combating PEM and iron deficiency anaemia in growing children and pregnant and lactating women in India.

Keywords: Muffins; garden cress seeds; sensory; protein; minerals; dietary fiber.

1. INTRODUCTION

Garden cress (*Lepidium sativum* L.) seeds are one of the underutilized and unexplored natural crops. It is an annual, herbaceous edible plant belonging to *Brassicaceae* family, native to South west Asia, Egypt and was referred to over many centuries back in Western Europe [1]. In India, it is cultivated for culinary and medicinal uses [2]. The leaves, seeds and roots of garden cress are very important for commercial value however, this crop is mostly grown for seeds purpose [3]. The seeds appear reddish brown in colour, small in size, oval in shape, pointed and triangular at one end, smooth, length and width of about 3-4 mm and 1-2 mm respectively. When garden cress seeds soaked in water the seeds coat swells and get covered with colourless, transparent and mucilage with mucilageous taste [4]. The Indian Council of Medical Research categorized GCS (*Lepidium sativum* L.) under nuts and oil since they contain high amount of fats and calories hence need to be consumed in less quantity compared to other food groups.

Garden cress seeds (GCS) are packed with potent nutrients; protein (23.36 g), ash and fibre (6.37 g and 8.27 g), carbohydrates (33.66 g), fat (23.74 g), calcium (318 mg), iron (12.20 mg), zinc (4.83 mg) and selenium (54.41 µg) [5]. Moreover, garden cress seeds are rich in essential amino acids, essential fatty acids and blessed with a perfect combination of PUFA (46.8%) and MUFA (37.6%). Its oil contains natural antioxidants such as vitamin A, E (tocopherol, phytosterol and carotenoids) and eugenol which help to protect the cell from oxidative rancidity [6,7]. It also contains essential amino acids (47.08%) [8] leaded by lysine (6.26 g/100 g) and phenylalanine (5.65 g/100 g) whereas methionine is minimum (0.97 g/100 g) [9].

GCS are helpful in preventing and curing disease in various ways such as ponding them in water and consume orally as remedy for skin disease

caused by blood impurities, diarrhoea and dysentery. The mixture of powdered garden cress seeds and sugar is also used to cure ingestion, diarrhoea and dysentery [10]. Chewed seeds help to treat asthma, headache, cough and sore throats but large quantity use induces abortion. It helps in relieving pain and swelling when the seed paste applied to rheumatic joints [11]. Also, it is an effective medicine to increase breast milk production and secretion to lactating women when consuming one tea spoon of garden cress seeds which is boiled in 6 ounces of water for 30 minutes and decoction with a table spoon full of honey [12].

Generally, garden cress seeds have various medicinal properties such as antispasmodic, diuretic, antidiabetic, emmenagogue, hypocholesterolemic, nephroprotective, antipyretic, antiinflammatory, nephrocurative and hepatoprotective [13]. Furthermore, it improves haemoglobin level due to its high iron content hence prevent iron deficiency anaemia [14]. The addition of small amount of garden cress seeds in recipe can be enough remedy to remove anaemia at a very low cost.

Despite being highly nutritious with several health benefits, garden cress seeds are not consumed much by the population because of its tanginess and peppery after taste and unpleasant taste and aroma which can be minimized by soaking, roasting, powdered or incorporating in food products [15]. Since, garden cress seeds are nutritionally rich, highly available, easily accessible, costly affordable by people of all social economics status, this study is designed to develop garden cress seeds supplemented muffins, analyse its sensory and nutritional properties so as to utilize its potential at maxima.

2. MATERIALS AND METHODS

This study was carried out in the Department of Foods and Nutrition, Chaudhary Charan Singh

Haryana Agricultural University (CCSHAU), Hisar. Garden cress seeds and other ingredients for development of muffins such as refined flour, sugar, eggs, refined oil, baking powder and vanilla essence were procured in a single lot from Goyals supermarket, Hisar, India.

2.1 Preparation of GCS Powder

Garden cress seeds were hand sorted to remove dust, sand, stones and other unwanted materials then roasted at temperature of ~150°C for 5 minutes. Roasted garden cress seeds were cooled for sometimes then grinded by using electric grinder to get flour which was sieved into 60 meshes before packed into a plastic container for their use in muffins development.

2.2 Development of GCS Supplemented Muffins

The control muffins were prepared with refined flour (100 g) as basic ingredient which was replaced by 10, 20 and 30% of garden cress seeds flour in experimental muffins. Other ingredients used in preparation of muffins were powdered sugar, eggs, refined oil, baking powder and vanilla essence. Refined flour and baking powder were sieved together, sugar and oil were creamed together with the help of electric beater then beaten whole eggs were added and beaten to stiff mixture before adding powdered sugar and the mixture was mixed well. The sieved flour was added into the mixture and mixed well to get the required consistency then few drops of vanilla essence were added. The batter was

poured into the greased muffin tins and baked into pre-heated oven temperature of 150°C for 25 minutes.

2.3 Sensory Evaluation of GCS Supplemented Muffins

The prepared muffins were analysed for sensory characteristics with respect to colour, appearance, aroma, texture, taste and overall acceptability using 9- point hedonic scale by 20 semi-trained panellists. The acceptability was expressed as liked extremely, liked very much, liked moderately, liked slightly, disliked moderately, disliked very much and disliked extremely from 9 to 1 point, respectively.

2.4 Nutrition Analysis

The prepared muffins were analysed for proximate composition, dietary constituents and total calcium, iron and zinc according to the methods described by AOAC [16], Furda [17], and Lindsey & Norwell [18], respectively. The sample for *in vitro* bio accessible calcium and zinc were determined according to Kim & Zemel [19] whereas *in vitro* bio-accessible iron was determined by Rao & Prabhavathi [20]. The determination of Phytic acid was done by the method of Davies & Reid [21]. Total phenol determined by the Folin–Ciocalteu colorimetric method [22] and DPPH radical scavenging activity was determined by the method of Brand-Williams et al. [23] as previously described by [24] Tadhani et al. [24].



Plate 1. Garden cress supplemented muffins

2.5 Statistical Analysis

The triplicates data obtained were subjected to statistical analysis for analysis of variance in a complete randomized design by OPSTAT software developed by Sheoran & Pannu [25] available at www.hau.ac.in and SPSS for windows. Standard errors of means were used to state the difference within the sample.

3. RESULTS AND DISCUSSION

3.1 Sensory Evaluation

The mean sensory scores of colour, appearance, aroma, texture, taste and calculated overall acceptability of control and garden cress seeds supplemented muffins have been presented in Fig. 1. Mean scores of colour, appearance, aroma, texture, taste and overall acceptability of control muffins were 7.70, 7.80, 7.50, 7.30, 7.80 and 7.62 respectively, and were found in the category of 'liked moderately' by the judges. The mean scores of same parameters for type-I, type-II and type-III muffins varied from 7.10 to 8.20, 7.30 to 8.30, 7.30 to 8.30, 7.50 to 8.20, 7.40 to 8.30 and 7.52 to 7.90 respectively, and these were adjudged between 'liked moderately' to 'liked very much'.

The results of sensory parameters of muffins are in close agreement with that of earlier workers who incorporated garden cress seeds in development of products [26,27,28]. Elizabeth & Poojara [29] developed cookies and muffins using garden cress seeds with 5 to 30% levels of

incorporation of GCS and observed 10% level as the most acceptable for the development of cookies and muffins. Rajshri & Haripriya [30] found 5% level as the most acceptable level for the development of muffins. In present study, GCS were roasted before incorporation in muffins development which imparted a pleasant aroma and that may be the reason for rating 20% level as the most acceptable level for muffins development.

3.2 Proximate Composition

Muffins prepared with 100% refined flour contained 21.68% moisture, 12.10% crude protein, 20.32% crude fat, 1.29 crude fibre, 1.31 ash and 43.30 total carbohydrates, which were found to be increased significantly ($P \leq 0.05$) in type-I, type-II and type-III muffins except moisture and total carbohydrates contents. Both the contents of moisture and total carbohydrates were decreased in muffins on each supplementing level of GCS. However, the differences were not found significant for moisture though they were significant for total carbohydrates. Moisture, crude protein, crude fibre, crude fat, ash and total carbohydrate of type-I, type-II and type-III muffins ranged from 15.65 to 19.61, 13.23 to 15.59, 20.57 to 20.99, 1.69 to 2.83, 1.77 to 2.64 and 42.30 to 43.13%, respectively (Table 1). Type-III muffins had the maximum contents of crude protein, crude fat, crude fibre and ash whereas the maximum contents of moisture and total carbohydrates were found in type-I muffins.

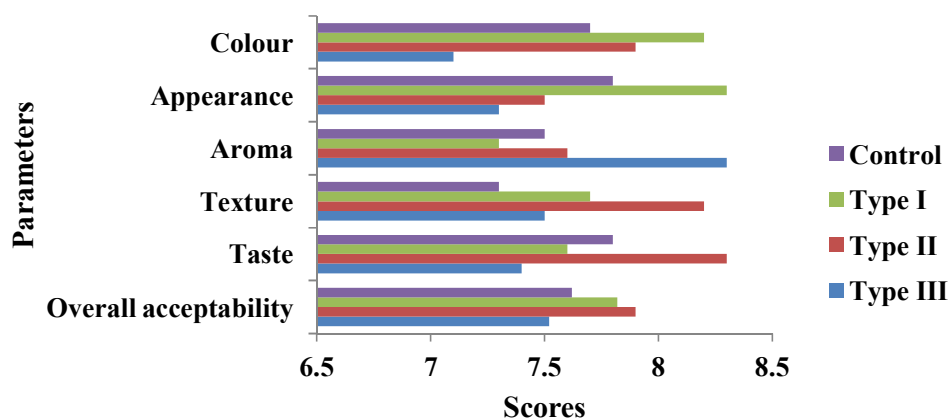


Fig. 1. Mean sensory scores of GCS supplemented muffins

Results of present study are in the close agreement with those reported by previous co-workers [31,32,33,34,35,36]. Similar increase for these nutrients after supplementing with GCS was observed in *pinni panjiri laddoo, burfi, chikki* and biscuits supplemented with 5 to 25% [37], *namakpara* and *laddoo* supplemented with 5 to 15% [38], *khakhra* supplemented with 5 to 30% [39] and cookies supplemented with 2.5 to 10.5% [40] level of GCS.

3.3 Dietary Fiber

Soluble dietary fibre content of control muffins was 2.41%. On the various levels of supplementation of GCS, soluble dietary fibre of muffins was decreased slightly however this decline was observed as non significant. Soluble dietary fibre of GCS supplemented muffins was in the range of 2.32 to 2.38%. Insoluble and total dietary fibre contents of control muffins were found to be 3.43 and 5.84%, respectively which were increased significantly ($P \leq 0.05$) with each level of supplementation of GCS (Table 2). Type-III muffins had highest insoluble (10.05 %) and total (12.37%) dietary fibre followed by type-II and in type-I muffins. That might be due to the higher content of insoluble and total dietary fibre of GCS than that of control formulation.

Results on dietary fiber are corroborated with those of Doke et al. [41] who analysed the dietary fibre profile of *chikki* supplemented by 10% of GCS and observe that *chikki* contained 8.5, 4.3 and 12.7% of soluble, insoluble and total dietary fibre, respectively.

3.4 Total and *in vitro* Bio-Accessible Minerals

Calcium, iron and zinc contents of muffins were observed as 58.98, 2.21 and 2.03 mg/100 g, respectively those were varied from 91.32 to 155.99, 0.17 to 0.20 and 2.24 to 2.67 mg/100 g

within three types of GCS supplemented muffins being highest in Type-III muffins and lowest in type-I muffins.

Control muffins contained 30.00, 10.50 and 16.00% bio accessibility of calcium, iron and zinc respectively; those were decreased slightly with the supplementation of 10, 20 and 30% of GCS. The per cent availability of calcium, iron and zinc among GCS supplemented muffins ranged from 24.00 to 28.00, 12.00 to 18.00 and 10.00 to 14.00%, respectively (Table 3). Type-I muffins had maximum per cent availability of calcium, iron and zinc. It was observed that the contents of total and *in vitro* bio accessible calcium, iron and zinc of GCS supplemented muffins were increased significantly in all the muffins with each level of supplementation than that of control formulations. That increase might be due to high mineral (calcium, iron and zinc) profile of GCS and further roasting increased the per cent availability of iron, calcium and zinc. Increased mineral profile of GCS supplemented *dahiwala* bread, *laddoo, mathri* and *shakkarpore*, nutri-cereals based *laddoo* and iron rich flour was also observed by Agarwal & Sharma [42], Chaudhary & Gupta [43], Patel & Dutta [44] and Gurjar & Mogra 2018 [45]. Iron and protein rich products play important role in improving iron status of anaemic population. Garden cress seeds supplemented products have been shown their efficacy in reducing anaemia at significant level in children and adolescent girls [46,47,48].

3.5 Phytic Acid and Antioxidants

It was observed that phytic acid content in three types of GCS supplemented muffins varied from 410.97 to 590.22 mg/100 g being lowest in type-I and highest in type-III muffins. This difference might be due to the varied level of GCS supplemented into muffins as 10% of garden cress seed contained less phytic acid compared to 30% of garden cress seeds (Table 4).

Table 1. Proximate composition of GCS supplemented muffins (% DM)

Treatments	Moisture*	Crude protein	Crude fat	Crude fibre	Ash	Total CHO's
Control	21.68±0.26	12.10±0.19	20.32±0.23	1.29±0.17	1.31±0.16	43.30±0.73
Type-I	19.61±0.17	13.23±0.21	20.57±0.23	1.69±0.16	1.77±0.23	43.13±1.01
Type-II	17.68±0.27	14.38±0.16	20.75±0.27	2.21±0.24	2.22±0.22	42.76±1.16
Type-III	15.65±0.24	15.59±0.23	20.99±0.24	2.83±0.18	2.64±0.22	42.30±1.10
CD ($P < 0.05$)	NS	1.11	0.59	0.45	0.43	0.90

Values are mean \pm SD of three independent determinations, NS-Non significant Muffins control: 100% refined flour. Type-I: GCSF@10%, Type-II: GCSF @20%, Type-III: GCSF @ 30%; GCSF: Garden cress seeds flour. * Moisture was analysed on fresh weight basis

Table 2. Dietary fibre in GCS supplemented muffins (% DM)

Treatments	Soluble dietary fibre	Insoluble dietary fibre	Total dietary fibre
Control	2.41±0.22	3.43±0.26	5.84±0.48
Type-I	2.38±0.24	5.60±0.25	7.98±0.49
Type-II	2.35±0.30	7.77±0.23	10.12±0.54
Type-III	2.32±0.23	10.05±0.23	12.37±0.45
CD ($P<0.05$)	NS	0.08	2.16

Values are mean ± SD of three independent determinations, NS-Non significant Muffins control: 100% refined flour. Type-I: GCSF@10%, Type-II: GCSF @20%, Type-III: GCSF @ 30%; GCSF: Garden cress seeds flour.

Table 3. Total and (in vitro) bio accessible minerals in GCS supplemented muffins (% DM)

Treatment	Ca (mg/100g)		Fe (mg/100g)		Zn (mg/100g)	
	Total	Available	Total	Available	Total	Available
Control	58.98±0.23	17.69±0.07 (30.00)	3.21±0.23	0.59±0.02 (18.50)	2.03±0.23	0.32±0.08 (16.00)
Type-I	91.32±0.28	25.57±0.08 (28.00)	4.83±0.23	0.87±0.02 (18.00)	2.24±0.22	0.31±0.07 (14.00)
Type-II	123.66±0.15	32.15±0.05 (26.00)	6.44±0.23	0.96±0.02 (15.00)	2.45±0.17	0.29±0.06 (12.00)
Type-III	155.99±0.28	37.44±0.08 (24.00)	8.06±0.22	0.96±0.02 (12.00)	2.67±0.23	0.27±0.08 (10.00)
CD ($P<0.05$)	9.91	7.24	0.56	0.11	0.12	0.04

Values are mean ± SD of three independent determinations. Muffins control: 100% refined flour. Type-I: GCSF@10%, Type-II: GCSF @20%, Type-III: GCSF @ 30%; GCSF: Garden cress seeds flour

Table 4. Phytic acid and antioxidants in GCS supplemented muffins (% DM)

Treatments	Phytic acid (mg/100g)	Total phenol (mgGAE/100g)	DPPH radical scavenging activity (mgTE/100gm)
Control	320.31±0.28	42.38±0.18	32.43±0.23
Type-I	410.97±0.29	47.91±0.17	42.14±0.23
Type-II	499.64±0.16	54.24±0.29	51.97±0.23
Type-III	590.22±0.17	59.49±0.15	62.06±0.28
CD ($P<0.05$)	23.77	3.22	6.18

Values are mean ± SD of three independent determinations, NS-Non significant Muffins control: 100% refined flour. Type-I: GCSF@10%, Type-II: GCSF @20%, Type-III: GCSF @ 30%; GCSF: Garden cress seeds flour

Total phenol and DPPH radical scavenging activity was found to be increasing in all the garden cress seeds supplemented muffins i.e. 42.38 to 59.49 mgGAE/100 g and 42.14 to 62.06 mgTE/100 gm, respectively. That might be due to the excellent amount of antioxidants present in garden cress seeds. Quantitative contribution of phenols, flavonoids, vitamin C, β -carotene, tocopherol and other plant constituents having antioxidants properties decide the antioxidant activity of any plant food. GCS possess strong capacity and therefore its products too [49].

4. CONCLUSION

Muffins prepared by incorporating GCS up to 30% level were found to be organoleptically

acceptable. Roasting garden cress seeds at ~150°C for 5 minutes successfully removed the tanginess and peppery after taste and also improved the texture, palatability and increased the mineral contents of the seeds. The contents of crude protein, fibre, ash, calcium, iron and antioxidants of GCS incorporated muffins were significantly ($P<0.05$) higher than that of control muffins. As the fact that garden cress seeds supplemented muffins contained the reasonable amount of iron and protein so the products can serve as a health snack for malnourished population such as protein energy malnutrition (PEM), anaemic and micronutrients deficiencies. The observed results in incorporated muffins may be used as a vessel to carry the functional ingredients in foods and improve the utilization of garden cress seeds as it is less known healthy

seeds hence uplift the nutritional status of the whole population.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

ACKNOWLEDGEMENTS

The first author acknowledges Indian Council of Agricultural Research (ICAR) under India-Africa Programme III for providing fellowship to conduct this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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